

AMENDMENTS TO THE CLAIMS:

1. (Currently amended) A fluid coupler comprising:

a female coupler member; and

a male coupler member; ~~wherein~~

wherein said female coupler member comprises:

(i) a cylindrical member including an axial through hole having a first opening end for receiving said male coupler member and a second opening end opposite to said first opening end, said cylindrical member further including

(a) a first radial through hole radially extending through said cylindrical member, and

(b) a second radial through hole radially extending through said cylindrical member, said first radial through hole being positioned nearer to said first opening end than is said second radial through hole;

(ii) a first locking ball received in said first radial through hole such that said first locking ball is radially movable in said first radial through hole;

(iii) a second locking ball received in said second radial through hole such that said second locking ball is radially movable in said second radial through hole;

(iv) a locking ball confining ring axially slidably disposed around said cylindrical member and having an inner surface ~~formed with~~ including

(a) a first locking ball relieving portion enabling said first locking ball to move radially outwardly to allow said male coupler member to be inserted into said axial through hole passing said first locking ball;

(b) a first slanted portion extending radially inwardly from said first locking ball relieving portion in a direction toward one of said first and second opening ends, said first slanted portion being axially aligned and engaged with said first locking ball;

(c) a second locking ball relieving portion enabling said second locking ball to move radially outwardly to allow said male coupler member to advance in said axial through hole passing said second locking ball;

(d) a second slanted portion extending radially inwardly from said second locking ball relieving portion in ~~said~~ the direction toward said one of said first and second opening ends, said second slanted portion being axially aligned and engaged with said second locking ball; and;

(e) a second locking ball pressing portion axially extending from ~~an~~ a radially inward end of said second slanted portion; and;

(v) a spring urging said locking ball confining ring towards the other of said first and second opening ends; and;

wherein

(1) when said male coupler member is not inserted into said female coupler member, said first locking ball is engaged by said first slanted portion to partly extend into said axial through hole, and said second locking ball is engaged by said second ball pressing portion to partly extend into said axial through hole,

(2) when said first locking ball is engaged by said male coupler member, which is being inserted into said axial through hole from said first opening end, ~~the~~ said first locking ball is forcibly moved radially outwardly while moving said locking ball confining ring in an axial direction under a force applied by said first locking ball to said first slanted portion, thereby allowing said male coupler member to advance into said axial through hole,

(3) when said male coupler member comes into engagement with said second locking ball after passing said first locking ball, said locking ball confining ring has been moved such that said locking ball pressing portion disengages from said second locking ball, thereby allowing said second locking ball to be moved radially outwardly to allow ~~the~~ said male coupler member to advance further; and;

(4) said male coupler member has an annular groove formed in ~~the~~ an outer surface thereof which is radially aligned with said first and second locking balls, which have been moved radially outwardly to said first and second locking ball relieving portions, respectively, to receive ~~the~~ said first and second locking balls thereinto so that said locking ball confining ring is returned by said spring to an initial position which said ~~sleeve~~ locking ball confining ring takes when said male coupler member is not inserted into said axial through hole of said female coupler member.

2. (Currently amended) A ~~The fluid coupler as set forth in~~ according to claim 1, wherein;

said second slanted portion is designed so that when said second locking ball pressing portion is disengaged from said second locking ball, said second slanted portion engages with ~~the~~ said second locking ball and, as said male coupler member advances while engaging with said second locking ball, said second locking ball is forced against said second slanted portion to thereby move said locking ball confining ring axially against said spring.

3. (Currently amended) A ~~The fluid coupler as set forth in~~ according to claim 1, further comprising:

a sleeve, axially movably disposed around said cylindrical member, interposing said locking ball confining ring between said cylindrical member and said sleeve,

wherein said sleeve ~~being~~ is designed so that, when said sleeve is moved towards said one of said first and second opening ends, said sleeve engages with and moves said locking ball confining ring against said spring to a position ~~wherein~~ such that said first and second locking ball relieving portions are radially aligned with said first and second locking balls, respectively.

4. (Currently amended) A ~~The fluid coupler as set forth in~~ according to claim 2, wherein said inner surface of said locking ball confining ring ~~comprises~~ further includes:

(i) a first annular surface having a predetermined axial length;

(ii) a second annular surface axially spaced away from said first annular surface and having a predetermined axial length and a diameter smaller than that of said first annular surface;

(iii) a slanted annular or conical surface extending between said first and second annular surfaces; and

(iv) a recess extending from a portion on said second annular surface adjacent to said slanted or conical annular surface and extending along said slanted or conical annular surface towards said first annular surface;

with

(a) said first locking ball relieving portion being formed by said first annular surface;

(b) said first slanted portion being formed by said slanted or conical annular surface;

(c) said second slanted portion being formed by said recess;

(d) said second locking ball pressing portion being formed by a portion of said second annular surface, which portion is axially aligned with said recess; and

(e) said second locking ball relieving portion being formed by a portion of said recess, a ~~the~~ diameter of which is the same as that of said first annular surface.

5. (Currently amended) A coupler member of a fluid coupler, comprising:
a cylindrical member having an axial through hole; and
a valve mechanism disposed in said axial through hole, ~~of said cylindrical member~~; said valve mechanism ~~comprising:~~ including

(i) a valve holder slidably disposed in said axial through hole, said valve holder being axially movable in said axial through hole between an opening position and a closing position;

(ii) a rotatable valve;

(iii) a pivotal shaft for pivotally supporting said rotatable valve about a pivotal axis extending transversely with respect to said valve holder; and

(iv) a cam mechanism for effecting a rotational movement of said rotatable valve about said pivotal axis between an opening angular position wherein said rotatable valve allows fluid to flow through said coupler member, and a closing angular position wherein said rotatable valve prevents fluid from flowing through said coupler member in response to ~~the~~ movement of said valve holder between said opening position and said closing position, respectively;

said cam mechanism having a cam profile hole extending through said rotatable valve; and a pin arranged such that ~~the~~ said pin extends through said cam profile hole;

wherein said cam profile hole cooperates with said pin such that when said valve holder is moved between said opening and closing positions, said pin engages with a wall defining

said cam profile hole so that said rotatable valve is rotated between said opening angular position and said closing angular position.

6. (Currently amended) A ~~The coupler member as set forth in~~ according to claim 5, wherein

said cam profile hole extends in a direction of said pivotal axis and along a cam profile in a plane normal to said pivotal axis; and;

said pin extends in parallel ~~with~~ to said pivotal axis.

7. (Currently amended) A ~~The coupler member as set forth in~~ according to claim 6, wherein

said pin is held in a predetermined position in a direction of ~~said~~ an axis of said axial through hole such that said pin is movable in a plane normal to said axis of said axial through hole ~~of said cylindrical member~~.

8. (Currently amended) A ~~The coupler member as set forth in~~ according to claim 7, wherein

said valve holder comprises a first cylindrical portion having a first axial through hole, an intermediate portion and a second cylindrical portion having a second axial hole, which are successively arranged in ~~that~~ this order along ~~the~~ an axis of said valve holder;

said intermediate portion has left and right side walls extending between said first and second cylindrical portions to rotatably hold said rotatable valve between said left and right side walls with a pair of pivotal ~~shafts~~ shaft portions which are respectively positioned between said rotatable valve and said left and right walls along said pivotal axis to rotatably support said rotatable valve about said pivotal axis; with said pair of pivotal shaft portions defining said pivotal shaft.

said left and right side walls have inclined elongated holes which are aligned with each other in ~~the~~ a direction of said pivotal axis;

said pin passes through said inclined elongated holes and ~~are~~ is supported by said cylindrical member such that said pin is movable in said plane normal to said axis of said axial through hole;

said rotatable valve has a through hole which is in axial alignment with said first and second axial through holes to allow fluid to ~~flowing~~ flow through said coupler member when said rotatable valve is in said opening angular position, and; which is out of said axial alignment with said first and second axial through holes when said rotatable valve is in said closing angular position, and;

when said valve holder is moved between said opening position and said closing position, said pin is slidably engaged by walls of said inclined elongated holes to thereby be moved in said plane normal to said axis of said axial through hole ~~of said cylindrical member~~.

9. (Currently amended) A fluid coupler comprising:

a female coupler member; and

a male coupler member; ~~wherein~~

wherein said female coupler member comprises:

(i) a cylindrical member including an axial through hole having a first opening end for receiving said male coupler member and a second opening end opposite to said first opening end, said cylindrical member further including

(a) a first radial through hole radially extending through said cylindrical member, and

(b) a second radial through hole radially extending through said cylindrical member, said first radial through hole being positioned nearer to said first opening end than is said second radial through hole;

(ii) a first locking ball received in said first radial through hole such that said first locking ball is radially movable in said first radial through hole;

(iii) a second locking ball received in said second radial through hole such that said second locking ball is radially movable in said second radial through hole;

(iv) a locking ball confining ring axially slidably disposed around said cylindrical member and having an inner surface ~~formed with~~ including

(a) a first locking ball relieving portion enabling said first locking ball to move radially outwardly to allow said male coupler member to be inserted into said axial through hole passing said first locking ball, and;

(b) a first slanted portion extending radially inwardly from said first locking ball relieving portion in a direction toward one of said first and second opening ends, said first slanted portion being axially aligned and engaged with said first locking ball;

(c) a second locking ball relieving portion enabling said second locking ball to move radially outwardly to allow said male coupler member to advance in said axial through hole passing said second locking ball;

(d) a second slanted portion extending radially inwardly from said second locking ball relieving portion in ~~said~~ the direction toward said one of said first and second opening ends, said second slanted portion being axially aligned and engaged with said second locking ball; and;

(e) a second locking ball pressing portion axially extending from ~~an~~ a radially inward end of said second slanted portion; and;

(v) a spring urging said locking ball confining ring towards the other of said first and second opening ends; and;

wherein

(1) when said male coupler member is not inserted into said female coupler member, said first locking ball is engaged by said first slanted portion to partly extend into said axial through hole, and said second locking ball is engaged by said second ball pressing portion to partly extend into said axial through hole,

(2) when said first locking ball is engaged by said male coupler member, which is being inserted into said axial through hole from said first opening end, ~~the~~ said first locking ball is forcibly moved radially outwardly while moving said locking ball confining ring in an axial direction under a force applied by said first locking ball to said first slanted portion, thereby allowing said male coupler member to advance into said axial through hole,

(3) when said male coupler member comes into engagement with said second locking ball after passing said first locking ball, said locking ball confining ring has been moved such that said locking ball pressing portion disengages from said second locking ball, thereby allowing said second locking ball to be moved radially outwardly to allow ~~the~~ said male coupler member to advance further; and;

(4) said male coupler member has an annular groove formed in ~~the~~ an outer surface thereof which is radially aligned with said first and second locking balls, which have been moved radially outwardly to said first and second locking ball relieving portions, respectively, to receive ~~the~~ said first and second locking balls therein so that said locking ball confining ring is returned by said spring to an initial position which said ~~sleeve~~ locking ball confining ring takes when said male coupler member is not inserted into said axial through hole of said female coupler member, and

and wherein said female coupler member further comprises:

a valve mechanism disposed in said axial through hole, ~~of said cylindrical member~~; said valve mechanism ~~comprising~~ including:

(i) a valve holder slidably disposed in said axial through hole said valve holder being axially movable in said axial through hole between an opening position and a closing position;

(ii) a rotatable valve;

(iii) a pivotal shaft for pivotally supporting said rotatable valve about a pivotal axis extending transversely with respect to said valve holder; and;

(iv) a cam mechanism for effecting a rotational movement of said rotatable valve about said pivotal axis between an opening angular position wherein said rotatable valve allows fluid to flow through said female coupler member, and a closing angular position wherein said rotatable valve prevents fluid from flowing through said female coupler member in response to ~~the~~ movement of said valve holder between said opening position and said closing position, respectively;

said cam mechanism having a cam profile hole extending through said rotatable valve; and a pin arranged such that ~~the~~ said pin extends through said cam profile hole;

wherein said cam profile hole cooperates with said pin such that when said valve holder is moved between said opening and closing positions, said pin engages with a wall defining said cam profile hole so that said rotatable valve is rotated between said opening angular position and said closing angular position.